ANNALS
OF
The Entomological Society of America

Volume XI SEPTEMBER, 1918 Number 3

# THE THORACIC SCLERITES OF HEMIPTERA AND HETEROPTERA.*

## With Notes on the Relationships Indicated.

By Leland H. Taylor.

### INTRODUCTION.

This paper is intended primarily as a contribution to the morphology of the thoracic sclerites of "Hemiptera" (*sensu lato*). Incidentally it may offer some suggestions as to the relationships of the families of the order, but these can be only suggestions, since the morphology of the thorax alone can contribute but a share toward the determination of phylogeny or relationships.

But little has been written on the morphology of the Hemipterous thorax. A number of articles were found dealing with a certain family, genus, or species, but in most instances the thorax was not studied in detail and generally no attempt was made to harmonize the results with the present day conception of the thorax, or to use a terminology applicable to all insects.

Thanks are due Doctor G. C. Crampton for his assistance in interpreting the homologies of the sclerites and for the loan of valuable material to work with. His papers (Crampton, 1908-09, 1914A, 1914B, 1914C) have been indispensable in the preparation of this paper, and the nomenclature employed by him has been generally adopted here. The writer would also express his thanks to Doctor H. T. Fernald for his interest and helpful criticism.

* Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass. This paper is presented as part of a thesis for the degree of Master of Science.

It has seemed advisable in this study to make drawings of at least one thoracic segment of a member of each available family of the Hemiptera. It is not necessary to present all of these, for many families resemble each other closely in the thoracic structure and separate drawings of these would be largely repetitions. One or two families, on the other hand, are omitted owing to an unfortunate lack of suitable specimens for study. The observations on the Psyllidæ as well as Figures 10 and 11 have been derived from the excellent monograph of Crawford, 1914, on that family, the present writer having been unable to secure specimens for study. Only drawings of such forms as show marked deviation from the simpler type, and of such individuals as offer features of particular interest are presented.

A slight attempt has been made at the end of the paper to group those families which from their thoracic sclerites appear to be more closely related. The grouping is made without regard to other morphological features and thus may not be entirely correct. It is hoped, however, that it may suggest, in combination with other morphological characters, some idea of the evolutional development of the Hemiptera.

Having studied only a limited number of species representing a family, the writer does not care to state that the characters of these species obtain throughout the family. For convenience, however, family names have been largely used in this paper where specific names would have been more correct, it being understood that, so used, they imply only those species studied by the writer. Nevertheless, there is apparently not much variation in a family, and one species may be considered as more or less typical of the entire family.

## LIST OF FORMS STUDIED.

In the preparation of this paper the following families and their representatives were studied. The writer has not attempted to arrange these in any logical order, but has followed the sequence of families in Comstock's "Manual" for the Homoptera and that of Banks' "Catalogue of the Nearctic Hemiptera-Heteroptera" for the Heteroptera.

SUBORDER HOMOPTERA.

| FAMILY | EXAMPLES STUDIED | FIGURES |
|---|---|---|
| Cicadidæ | Cicada tibicen | 1, 2, 3, 4, 5 |
| | Cryptotympana epithesia. | |
| Fulgoridæ | Fulgora sp. | 9 |
| | Ormenis sp. | 8 |
| | Amphiscepa bivittata. | |
| Cercopidæ | Aphrophora sp. | 6 |
| Jassidæ | Draeculacephala sp. | 7 |
| Membracidæ | Ceresa sp. | |
| Psyllidæ | Apsylla cistellata | 10 |
| | Arytaina robusta | 11 |
| Aphididæ | Pemphigus acerifolia | 12 |
| Aleyrodidæ | Aleyrodes vaporariorum | 13 |

SUBORDER HETEROPTERA.

| FAMILY. | EXAMPLES STUDIED. | FIGURES. |
|---|---|---|
| Corixidæ | Corixa sp. | 19 |
| Notonectidæ | Notonecta sp. | 15, 16 |
| Nepidæ | Ranatra sp. | 17 |
| | Nepa cinerea. | |
| Belostomatidæ | Belostoma americana | 18, 20 |
| | Zaitha sp. | |
| Reduviidæ | Sinea sp. | |
| Emesidæ | Emesa sp. | 14 |
| Nabidæ | Corsicus sp. | 24 |
| Cimicidæ | Cimex lectularius. | |
| Gerridæ | Gerris sp. | 21 |
| Capsidæ | Poecilocapsus sp. | |
| Phymatidæ | Phymata sp. | |
| Tingitidæ | Corythuca sp. | |
| Lygaeidæ | Lygaeus sp. | |
| Berytidæ | Neides sp. | 22 |
| Coreidæ | Anasa tristis | 23 |
| | Metapodius sp. | |
| Pentatomidæ | Brochymena sp. | |
| | Podisus sp. | |
| Thyreocoridæ | Thyreocoris sp. | 25 |

## GENERAL CONSIDERATIONS.

The Hemipterous thorax, while peculiarly developed in its higher forms, is in the more generalized individuals easily comparable to that of other insects. Indeed, the points of similarity between the thorax of *Cicada* and that of certain Neuroptera (*Mantispa* or *Corydalis*, for example) are very marked. In each of these forms the notum is similarly divided. Homologous plates occur at the base of the wings of each. The pleura, particularly, of these forms resemble each other, the episterna and epimera being in all cases divided into upper and lower portions by sutures. In certain Neuroptera, also, we find a third, median sclerite in the episternum homologous with a similar piece in certain Cicadidæ. The coxæ and sterna are also much alike in both Neuroptera and Cicadidæ.

DESCRIPTION OF A GENERALIZED HOMOPTEROUS THORAX.

Suborder Homoptera, Family Cicadidæ; *Cicada tibicen*, *Cryptotympana epithesia*. Figures 1, 2, 3, 4, 5.

These insects have been selected for detailed description as being probably rather primitive Hemiptera. They have the additional advantage of being comparatively large and therefore easy to study.

Between the thorax and the head are three pairs of small, free plates, the cervical intersegmentalia (Figures 2 and 3, is). These probably belong, partly to the head, partly to the prothorax. They may all be included under the term veracervix of Crampton, 1914B.

Prothorax. Figure 3.

This segment, as compared with the prothorax of the more specialized forms, is small, overlapping only a slight portion of the mesothorax.

Notum. Figure 3. The notum or tergum occupies the larger part of this segment, extending downward laterally for a considerable distance. There is a narrow pretergite (prt) marked off on the anterior margin and connected with the pleuron by a lateral extension which is homologous with the prealare (pra) in the wing bearing segments. There are no distinct sutures in the pronotum, but there are several grooves or furrows which mark off a triangular prescutum (psc), a scutum (sc), which is narrow mesally and widens as it approaches the pleuron, and a scutellum (sl), a rectangular band along the rear margin of the segment. The postscutellum is probably not represented in this segment.

Pleuron. Figures 2 and 3. The pleuron of the prothorax is much reduced and is closely joined to the notum. It is divided into an anterior portion, the episternum (es), and a posterior portion, the epimeron (em), by a short pleural suture (p). The episternum is small and is connected with the sternum by a narrow precoxal bridge, the precoxale (pcx), from which it is not distinctly separated. The epimeron is larger, overlapping the mesopleuron to some extent. It likewise is joined to the sternum, by a postcoxal bridge, the postcoxale (poc). The trochantin (tn) is rather broad, and when in position partly overlaps the base of the coxa (cx).

Sternum. Figures 2 and 3. The sternum (st) of the prothorax is narrow from front to rear and apparently consists of but one sclerite, which bears the furca, an interior projecting fork for muscle attachment. The coxa is divided into a front portion, the veracoxa (vcx), and a rear portion, the meron (me).

Mesothorax. Figures 1, 2 and 4.

The mesothorax is by far the largest and most typical segment.

Notum. Figures 1 and 4. The mesonotum, as in most insects, is divided primarily into two distinct plates. The first, which is that part of the notum visible externally, is roughly pentagonal in shape and is called the scuto-scutellum by Crampton, 1914A, 1914B. This portion has often been called notum, but this term should be applied only to the whole dorsal region of the segment. The second primary division of the notum is the postscutellum, which is concealed behind and somewhat beneath the scuto-scutellum, and hence is not shown in the figures.

The scuto-scutellum is in turn subdivided by various infoldings of chitin into several parts. The foremost of these is the anterior phragma (aph), which projects under the pronotum and is connected with it by membrane. Immediately behind this is the pretergite (prt), which is narrow and is fused with the rather large, bilobed prealare (pra) on either side. The latter, as is usual in the Hemiptera, connects the notum with the pleuron, anterior to the wing. Two distinct, nearly longitudinal sutures, which approach each other posterior to the middle of the tergum, mark off the prescutum (psc). The scutum (sc) is an ill-defined region just posterior to the prescutum, extending downward on either side and forming the major part of the whole scuto-scutellum. Where the scutum articulates with the wing base a small piece, the suralare or supralare (sr), is partly marked off by a cleft extending forward. (In some insects this piece is entirely separated from the scutum by a suture.) Another cleft extending backward partly defines a similar piece. These two pieces articulate with a free plate, the notopterale (npt), which forms one of the principal connections with the wing. The tegula (tg) in the Cicada is poorly chitinized, but its homologue is clearly seen in the membrane anterior to the base of the fore wing (Figure 1). A broken suture nearly parallel with the posterior margin of the

scuto-scutellum demarks the scutellum (sl). The posterior edge of the scutellum is produced on either side to a point which connects with the anal margin of the wing. Just anterior to this point, imbedded in the membrane, occurs a small triangular plate, the adanal pterale (apt), articulating with the bases of the anal veins. The postscutellum is a narrow piece entirely concealed beneath the edge of the scutellum and fused with the anterior phragma of the metathorax. It is connected with the mesoepimeron by a narrow postalar bridge (Figure 4, poa). This has been termed pleurophragmite, pleurotergite, and postalare by various authors. The term postalare appeals to the present writer, as there is a corresponding prealare in front of the wing.

Pleuron. Figures 2 and 4. The mesopleuron of the *Cicada* is decidedly primitive and resembles the condition found in certain Neuroptera. The pleural suture (p) is particularly distinct, extending from the wing base to the articulation of the coxa. The episternum (es) is divided by a suture (a) into an upper and a lower region, called respectively the anepisternum (aes) and the katepisternum (kes). The upper portion has often been wrongly designated as the whole episternum, but, as Crampton, 1914A, 1914B, has shown, the episternum always extends the entire length of the pleural suture. The anepisternum (aes) is partly divided vertically by a cleft running about parallel to and near the pleural suture. In *Cryptotympana epithesia*, a large Sumatran Cicadid, and probably in other forms, a median portion (mes), in addition to the upper and lower parts, is marked off on the episternum by sutures. A similar condition is to be observed in certain Neuroptera.

The katepisternum (kes), the precoxale, or precoxal bridge (pcx), and the sternum are indefinitely fused. Above the episternum at the base of the wing is a free sclerite, the posterior basalare (pba). Another plate a little in front of and below this sclerite is the anterior basalare (aba), which is only partly separated by a cleft from the episternum. The spiracle of the mesothorax is located anterior to the prealare and is surrounded by a chitinous plate, the peritreme (pt).

The epimeron (em), like the episternum, is divided into an upper region (aem) and a lower region (kem) by a prolongation (b) of the suture which divides the episternum. These regions have been designated variously as hyperepimeron or anepimeron

(the upper) and hypoepimeron or katepimeron (the lower) by Crampton, 1908, 1909. The same writer (Crampton, 1914B) has used the term pteropleurite for the upper part, this being a modification of Osten-Sacken's, 1884, term pteropleura of the Diptera. It seems reasonable, if we decide on the prefixes ana- and kata- for the two divisions of the episternum, to employ the corresponding terms anepimeron and katepimeron in this instance. These terms are both self-descriptive and logical, while pteropleurite might be taken to mean a part of the episternum.

The connection of the epimeron with the postscutellum (i. e., the postalare) has already been mentioned. This is always strongly fused with the epimeron and usually no suture is to be seen between the two. A postcoxal bridge, the postcoxale (poc), connects the katepimeron with the sternum. Above the epimeron at the wing base two plates, the anterior (asa) and the posterior subalares (psa), occur, supporting the anal region of the wing. The trochantin (tn) of the mesothorax is semicircular and rather broad. A continuation of the pleural suture in the coxa partly marks off the meron (me) from the veracoxa (vcx).

Sternum. Figures 2 and 4. The mesosternum consists of but two well defined sclerites, the basisternite (bs) and the furcasternite (fs).

Smith and Grossbeck, 1907, in figuring the ventral view of *Cicada tibicen*, have apparently misinterpreted the parts of the prothorax and the mesothorax. In a figure similar to the writer's Figure 2 they have called the mesothoracic anepisternum ($aes_2$) the proepimeron; they have designated the metathoracic katepisternum ($kes_2$) as the entire mesosternum; the mesothoracic anepimeron ($aem_2$) has been called mesoepisternum; and the mesothoracic katepimeron ($kem_2$) has been termed the entire mesoepimeron. The median sclerite ($mes_2$) of the mesothoracic episternum is labelled proepisternum. A comparison of the ventral view with the lateral aspect of the thorax of this insect will instantly establish the true relation of these parts, though it may not be apparent from the ventral view alone.

Metathorax.

The metathorax is similar in general make-up to the mesothorax.

Notum. Figure 5. The notum of the metathorax is narrow from front to rear. The prescutum (psc) is but a narrow band. The scutum (sc) is narrow at the summit and broadens as it reaches the wings. The scutellum (sl) is ill defined at the summit. It is produced laterally into a narrow band bearing the axillary cord, which is continuous with the anal margin of the wing. The postscutellum (psl) is also narrow and is joined by the postalare (poa) to the epimeron (em).

Pleuron. Figure 5. The metathoracic pleuron is divided by a distinct pleural suture (p). The episternum (es) is undivided and is fused ventrally with the precoxale (pcx). The posterior basalare (pba) rests on the anterior basalare (aba), while the latter rests on the episternum (es); all are closely united, but the sutures demarking them are distinct. A wide peritreme (pt) joined to the episternum surrounds the spiracle. The epimeron (em) of the female is large and rectangular. In the male a broad lobe (op), called sometimes the operculum, extends backward from the epimeron and sternum, forming a cover for the tympanum or sound producing organ. In either case the postcoxale is indistinct. An anterior (asa) and a posterior subalare (psa) support the anal part of the wing as in the mesothorax. The trochantin (tn) is long and narrow in this segment.

Sternum. Figures 2 and 5. The sternum of the metathorax consists of basisternite ($bs_3$, Figure 2; bs, Figure 5) and furcasternite ($fs_3$, Figure 2). The latter region together with the episternum is prolonged posteriorly to cover the tympanum in the male. The meral region (me) of the coxa bears on its posterior side a flattened spine or spur (mc), called by Fieber, 1875, the meracanthus.

## MODIFICATIONS IN OTHER HOMOPTERA.

It is difficult to trace the development of the Homoptera along definite directions toward the various modifications which characterize the higher forms. All the families show close relation to each other, but most of them possess striking features not comparable or traceable to features in others. The following are among the more striking modifications occurring throughout the Homoptera.

Prothorax. Figures 10 and 11.

The prothorax of Membracids is developed to extreme proportions. It covers a good part of the mesothorax and extends

dorsad nearly to the tip of the abdomen, terminating in a point. In the other families the prothorax is similar to that of *Cicada* (Figure 3), except that in the Psyllidæ (Figures 10 and 11), Aphididæ, Coccidæ and Aleyrodidæ it is even more collar like, scarcely overlapping the mesothorax.

Between the prothorax and the mesothorax of Psyllidæ (Figures 10 and 11) there are, according to Crawford, 1914, three small sclerites. One of these, the lower, is the peritreme (pt) surrounding the spiracle. Above this and often separated from it only by a line is a second sclerite (pt) which is probably part of the peritreme. The third of these sclerites (it) occurs behind the above mentioned two, and its origin is not easily traceable. Crawford, 1914, calls it an accessory sclerite. It would, however, probably come under the term intersegmentalia used by Crampton, 1914A, 1914B, and would thus be termed intertergite. Its homologue was not found in any of the forms treated in this paper.

Mesothorax. Figures 7, 10, 11 and 12.

Notum. The mesonotum in the other Homoptera differs only in detail from that of *Cicada*. The primary divisions—prescutum (psc), scutum (sc), scutellum (sl) and postscutellum (psl)—are always present. A well chitinized and fairly large tegula occurs in the mesothorax of Fulgorids (*Fulgora* sp.), but is not present in other families of Homoptera.

Pleuron. In the pleuron of the mesothorax several differences are noticeable. The basalares (aba, pba) disappear or become fused to the episternum in some families. The beginning of this is observable in *Cicada*, where the anterior basalare (aba) is only partly separated from the episternum by a cleft or notch. In the Fulgoridæ, Jassidæ (Figure 7) and Membracidæ no free basalares are to be seen, though one at least is probably present, fused with the episternum. On the other hand, there are usually two basalares (aba, pba) in Psyllids, (Figures 10 and 11), in the Aphids there is at least one (pba), and though they could not be detected by the writer on account of poor material, it is not improbable that one or two occur in the Coccids and Aleyrodids. The pleural suture (p) of the mesothorax is usually distinct among the Homoptera. In some Psyllids, however, it extends but halfway up the pleuron from the coxal attachment. The cleft or notch mentioned as running parallel to the pleural suture in the mesoepisternum

of the Cicadidæ persists in the Fulgoridæ, the Jassidæ (Figure 7) and the Membracidæ, greatly reduced. In the Aphididæ (Figure 12) it is even deeper and in the Psyllidæ (Figures 10 and 11) a probable trace of it remains.

The episternum in the Jassidæ (Figure 7) is subdivided into three parts (aes, mes, kes) as in the Cicadidæ, but in most of the other Homoptera all trace of these divisions is lost. In the Aphididæ (Figure 12) the episternum (es) of the mesothorax is divided into an upper and a lower portion, the anepisternum (aes) and the katepisternum (kes),* as in Cicadidæ, Jassidæ and Neuroptera, but the median plate is not present. In the Jassidæ (Figure 7) a narrow band (hyp) is marked off in front of the episternum and is produced into the sternum. This has been shown by Crampton, 1914C, to be the hypopteron of Audouin, 1820, termed the pre-episternum by Snodgrass, 1909. As in the Cicadidæ, the episternum is not separated from the sternum in the Fulgoridæ, Cercopidæ, Jassidæ, Membracidæ and Aphididæ. The mesothoracic trochantin (tn) is readily seen in all the families studied except the Psyllidæ, Aphididæ and Aleyrodidæ.

The epimeron does not present many differences among the Homoptera. The homologue of the suture dividing the epimeron of *Cicada* into upper and lower parts, however, has not been found in other families.

Sternum. The sternum of the mesothorax is considerably lengthened in all forms except the Membracidæ, where both mesothorax and metathorax are much condensed from front to rear. The coxa of this segment in the Fulgoridæ and the Cercopidæ bears sometimes a spur or meracanthus.

Metathorax. Figures 6, 8, 9, 10, 11, 12 and 13.

Notum. The notum of the metathorax in other Homoptera is usually longer than that of Cicadidæ. It is often shortest along the mid-dorsal line and longest as it approaches the wings. In the Aphididæ and the Psyllidæ this is not generally true, the median length of the notum being usually greater than the length of the lateral margin. In the Jassidæ the metanotum is nearly as long as the mesonotum.

*Attention is called to an error in labelling in Figure 12. The abbreviation $kes_2$ should refer to that part of the plate marked $pcx_2$ which is just anterior to the pleural suture ($p_2$). The abbreviation $pcx_2$ would then refer to an indefinite portion of this plate between $kes_2$ and the posterior part of $st_2$.

Pleuron. The metathoracic pleuron exhibits several points of difference from the primitive type. In the lower part of the episternum of the Cercopidæ (Figure 6) will be noticed a short suture running parallel to the pleural suture. In the Fulgoridæ (Figures 8 and 9) this suture is possibly represented by a membranous cleft, to be described later. The metapleuron, metasternum and metacoxa of the Fulgoridæ (Figures 8 and 9) present a very remarkable and puzzling condition. Hansen, 1890, figured and described the coxa and its surrounding parts, but was mistaken in his interpretation of the boundary of the coxa. He did not consider the upper portion of the part labelled meron (me) in Figures 8 and 9 as a part of the coxa. Since this plate bears muscles extending to the subalar region and such muscles characteristically connect the meron with that region in other insects, it is unquestionably a part of the coxa. The coxa is, indeed, so fused with the pleuron and sternum as to make these parts extremely difficult of interpretation. Added to this confusing state is the substitution of a considerable amount of membrane for chitin in these parts. On comparing Figures 8 and 9 it will be seen that there is a marked variation in the two forms. Essentially, however, they are very similar. In *Ormenis* sp. (Figure 8) the parts can be more easily identified. It will be noticed that in this form the coxa (cx) extends dorsally to a point not far from the wing base and that a lobe of the episternum covers the anterior part of the coxa to some extent. This lobe being transparent, the true limits of the coxa can be distinguished through it. That the coxa extends posteriorly to the point indicated in the figures is shown—as mentioned above—by the presence of characteristic muscles running from the subalar region to the meral region (me) of the coxa.

The coxa, then, in Fulgoridæ is rather extensive; it is divided into a true coxa, or veracoxa (vcx), and a large meron (me), which in turn is divided into two parts. The coxa is, moreover, immovable as a result of its close fusion with the other parts. The large non-chitinous areas in the pleural and sternal regions, however, probably impart a certain elasticity to the coxa, which doubtless compensates for its immobility to some extent. These membranous areas are to be found in the episternum, the epimeron and the sternum. In the episternum the membranous portion forms a cleft, nearly bisecting the

plate. In the epimeron a similar cleft is found, but this is nearly surrounded by chitin and does not open broadly as does that of the episternum. The sternum, save a small anterior plate and a piece between and behind the coxæ, is almost entirely membranous.

In the Cercopidæ (Figure 6) there occurs in the lower epimeron, partly covering the meron of the coxa, a flap-like process, which may be the homologue of a similar process on the lower epimeron of Fulgoridæ (Figure 9).

Also meriting particular mention are the pleuron, sternum and coxa of the Psyllid metathorax (Figures 10 and 11). In the generalized forms, *Apsylla* (Figure 10) for example, the pleuron and coxa are not radically different from those of other Homoptera, but in certain higher forms like *Arytaina robusta* (Figure 11) some remarkable conditions obtain. The pleuron, particularly the epimeron (em), is greatly reduced, while the coxa (cx) has become enormous. The pleural suture (p) no longer extends from the wing articulation to the coxal condyle, but seems to end arbitrarily on the lower margin of the pleuron. The coxal articulation (x) occurs at the center of the lower margin of the greatly reduced epimeron (em). The pleuron and coxa thus present the appearance of the latter having become extended far up the side of the body, replacing the former to a great extent. In this shifting the coxa seems to have carried with it along the lower margin of the pleuron its articulatory process (x), which in other forms, is almost universally found at the end of the pleural suture. In the Psyllids there is no distinct precoxale in the metathorax, but the narrow postcoxale (poc) is remarkably long and distinct. It is possible that the large trochantin ($tn_3$) figured by Crawford, 1914, may be a region homologous with the precoxale found in other forms. The coxa bears on its lower posterior side an articulated meracanthus (mc).

In the metathorax of Aleyrodidæ (Figure 13) the pleural suture (p) is only partly distinct, the upper part being wanting. A continuation of the pleural suture extends the entire length of the coxa, which is apparently fused with the pleuron.

Sternum. The sternum of Psyllidæ is represented by a very narrow sclerite between the coxæ, hardly visible from the side. Aside from this and the modifications noted above in the Fulgoridæ, the metathoracic sternum is fairly normal.

DESCRIPTION OF A GENERALIZED HETEROPTEROUS THORAX.

Suborder Heteroptera, Family Belostomatidæ; *Belostoma americana*, *Zaitha* sp. Figures 18 and 20.

The giant water bug (*Belostoma americana*) is described rather fully here, since it is a somewhat generalized Heteropteron. It is also of a convenient size to study and it is widely distributed.

Prothorax.

This segment, as in most Heteroptera, is somewhat collar like, fitting tightly to the head and closely overlapping the anterior part of the mesothorax. The notum is trapezoidal in outline and is rather large. The pleural region is somewhat broad above, narrowing to meet the narrow sternum. Rarely is the prothorax distinctly marked off into sclerites, and it is fundamentally so similar in all Heteroptera, that it will require but little mention.

Mesothorax. Figure 18.

Notum. The notum of the mesothorax does not show a distinct pretergite, this sclerite being probably represented by part of the anterior phragma (aph). The prescutum (psc), a semicircular piece, is marked off clearly. Extending in front of the wing from the lateral margin of the prescutum is a bilobed prealare (pra), the anterior lobe of which joins an upward projection of the sternal region. No separating suture occurs between scutum (sc) and scutellum (sl). The latter is produced backward to a point over the metanotum. A postscutellum (psl) is concealed under the scutellum and is connected by the postalare (poa) with the epimeron. Snodgrass, 1909, at first stated that no postscutellum was present in the mesothorax of of *Belostoma*. Later (Snodgrass, 1910), however, he noted the presence of this sclerite.

Pleuron. The mesopleuron in this and in other Heteroptera has the appearance of having been distorted from its normal form, i. e., the upper part seems to have been pushed forward, or the lower part backward. This brings about two remarkable conditions: first, the pleural suture (p) becomes almost horizontal, and second, the coxa (cx) extends outward from the rear of the segment instead of from beneath. Another peculiarity of this and other members of the suborder is the overlapping of the base of the coxa by the lower parts of the two pleural

plates. The episternum (es) is long and somewhat narrow. Its lower portion lies virtually below the coxa (cx) and hence has been called the subcoxal plate by some authors. It is evident, however, that it is really but a part of the episternum. Fused to the anterior (or to what is normally the dorsal) end of the episternum, the homologue of at least one of the two basalar plates (aba) occurs. The posterior basalare may also be present. The epimeron (em) is triangular in shape and lies above the episternum. It is produced posteriorly to a sharp point, which overlaps the metapleuron and bears dorsally a knob-like projection. This projection fits into a socket in the closed forewing to hold it fast.

Sternum. Owing to the aforementioned shifting of the pleural plates, the sternum lies along what would naturally be the anterior margin (but actually is the lower margin) of the episternum. The coxa (cx), as has been stated, proceeds from the rear of the segment, the attachment being concealed beneath the pleuron at a point marked (x). The trochantin is hidden beneath the episternum.

Metathorax. Figure 20.

Notum. The notum is not long mesally, but it lengthens as it reaches the wing. It is largely composed of the prescutum (psc) and the scutellum (sl), the other plates not being clearly defined, though the scutum (sc) is probably represented. The postscutellum (psl) is concealed and is fused with the narrow first abdominal tergite. The postalare (poa) is unusually broad where it joins the epimeron.

Pleuron. The pleuron of the metathorax overlaps the coxa to some degree. Like the mesopleuron, it is turned or twisted so that the pleural suture (p) is nearly horizontal. The episternum (es) is divided into an upper (aes) and a lower section (kes), but these may not be homologous with similar divisions in the mesopleuron of *Cicada* and related forms. The lower portion (kes), often designated as the subcoxal plate, is produced backward in a pointed flap, which reaches two-thirds the length of the coxa. The epimeron (em) is small, triangular and pointed posteriorly.

Sternum. The metasternum (st) is not clearly separated from the episternum. It is very similar to the sternum of the mesothorax. The hind coxa (cx) is very large.

MODIFICATIONS IN OTHER HETEROPTERA.

As in the Homoptera, it is difficult to trace the modifications of the higher Heteroptera along definite lines of development. Unlike the Homoptera, however, the higher families of Heteroptera show considerable departure from the primitive type, and resemble only slightly the Belostomatidæ and their near relatives. Of the forms studied only the Corixidæ (Figure 19), Notonectidæ (Figures 15 and 16), and Nepidæ (Figure 17) show characters very similar to *Belostoma*. The Nepidæ seem in a number of ways to be a connecting link between these and the more modified forms.

Before commencing the discussion of the modifications of the thorax in the Heteroptera, it may be well to mention Heymons', 1899, interpretation of the thorax of *Nepa cinerea*, since this work is frequently referred to by other writers. In the later larval stages, which he studied and figured, the body is much flattened dorso-ventrally. The pleural plates are thus apparently ventral. Heymons has hence called the episternum of the various segments the "lamina subcoxalis" or subcoxal plate (Subcoxalplatte), since its true position is beneath the coxa. The mesothoracic epimeron is a sickle-shaped flap, which extends beyond the hind coxa. This sclerite was considered by Heymons to be the metathoracic "pleurite," but that it is most certainly the mesothoracic epimeron is clearly seen by lifting the flap and observing its attachment. A sclerite which Heymons designates as paratergite, the writer believes from its location to be the metathoracic epimeron.

Prothorax.

This segment is fairly constant throughout the group. It may vary in size and shape, but in its ground plan it is essentially the same in all the families studied. It is of minor importance in the study of the sclerites, and is not figured in this paper. One notable exception obtains in the Gerridæ, where the scutellar region of the pronotum extends so far back as to entirely cover the mesonotum.

Mesothorax. Figures 14, 15, 17, 18, 19, 21, 22, 23, 24 and 25.

Notum. The notum of the mesothorax in the suborder Heteroptera is usually divided by sutures into pretergite (prt), prescutum (psc), scutum (sc), scutellum (sl) and postscutellum

(psl). In most families the scutellum (sl) is very prominent, and is always to be seen between the closed forewings, extending backward over the succeeding segment and terminating usually in a point. In some forms the scutellum (sl) becomes unusually extensive. In the Pentatomidæ it reaches beyond the metathorax and projects over the abdomen, in the Scutelleridæ it extends still farther, while in the Thyreocoridæ (Figure 25) it almost conceals the abdomen. The postscutellum (psl) is always closely attached to the anterior part of the next segment so that it is frequently difficult to ascertain its posterior limit. A prealare (pra) is almost invariably found in the mesothorax throughout the Heteroptera, and together with the anterolateral margin of the mesonotum and the upper anterior margin of the mesopleuron, it forms the boundary of an irregular, often more or less triangular, membranous region (i. e., the region posterior to pra, ventral to psc and dorsal to aba and es). In front of the prealare (pra) the spiracle, surrounded by its peritreme (pt), is usually to be seen. The postalare (poa) is usually narrow and often almost indistinguishably fused with the prescutum (psc) of the metathorax.

Pleuron. The mesopleuron exhibits a considerable degree of diversity in the suborder. Along the upper margin of the episternum (es) there is usually marked off a narrow plate (aba), probably the anterior basalare, which has become fused to the episternum. This fusion occurs in most Heteroptera. Often the posterior basalare (pba) is also distinguishable, usually above the anterior basalare; this, too, is often fused to the episternum. This plate (pba) occurs in the Emesidæ (Figure 14), Berytidæ (Figure 22) and Coreidæ (Figure 23).

In nearly all the Heteropterous families studied (except in the Notonectidæ, Nabidæ, Cimicidæ and Capsidæ) the pleural plates extend down over the upper part of the coxa (cx). In such cases the lower part of the pleuron is divided by a cleft (c) extending lateral to the coxa and terminating in the coxal articulation (x). From this coxal process, as the articulatory projection of the pleuron is called, the pleural suture, when present, extends dorsad. In the Heteroptera it is more often absent, being entirely visible only in the Corixidæ (Figure 19), Notonectidæ (Figures 15 and 16) and Belostomatidæ (Figure 18). In the Nepidæ (Figure 17), Capsidæ, Reduviidæ, and Thyreocoridæ (Figure 25) it is visible in part, extending dorsal-

ward from the coxal articulation (x) to a point about midway up the pleuron. The division of the pleuron is usually indicated on the inner side of the plate by a ridge, the internal representative of the pleural suture, even when the pleural suture itself is entirely absent. It must be mentioned here that the coxal cleft in the metathorax does not occupy a position homologous with that in the mesothorax and hence cannot be taken as a "landmark" for the separation of episternum and epimeron in that segment.

In the Nepidæ (Figure 17) and the Thyreocoridæ (Figure 25) the episternum of the mesothorax is divided into anepisternum (aes) and katepisternum (kes), a condition not general with the Heteroptera, but met with in Cicadidæ, Jassidæ and Aphididæ, among the Homoptera.

The distorted condition remarked above in connection with *Belostoma* is noticed also in the Corixidæ (Figure 19) and Notonectidæ (Figure 15). The backward projecting flap of the epimeron of *Belostoma* finds its homologue only in the Nepidæ (Figure 17), though in most forms the posterior margin of the epimeron overlaps more or less the anterior part of the next segment. In the higher Heteroptera, among them the Reduviidæ, Emesidæ (Figure 14), Nabidæ (Figure 24), Gerridæ (Figure 21), Capsidæ, Phymatidæ, Lygæidæ, Berytidæ (Figure 22), Coreidæ (Figure 23) and Pentatomidæ, the shape of the mesopleuron, and usually of the metapleuron is rectangular. The coxa (cx) retains its position at the rear of the segment even in the elongated forms, *Emesa* (Figure 14), *Gerris* (Figure 21) and *Neides* (Figure 22), for example. In the Gerridæ (Figure 21), where the body is very nearly cylindrical, the mesocoxa ($cx_2$) is partially encased by a cylindrical, bulging socket. The coxal cleft ($c_2$) runs the length of this socket. A trochantin (tn, Figure 15) is very probably present in most of the Heteroptera, though its position beneath the episternum prevents it from being easily detected.

Sternum. The mesothoracic sternum is usually indistinguishably fused with the pleuron, and consists apparently of a single sclerite. In some instances, namely in the Notonectidæ (Figure 15), Reduviidæ, Emesidæ (Figure 14), Cimicidæ, Phymatidæ and Tingitidæ, a faint line more or less distinctly marks off the sternum from the pleuron.

Metathorax. Figures 14, 16, 19, 20, 21, 22, 23, 24 and 25.

Notum. The metanotum varies in the Heteroptera from a size nearly equal to that of the mesonotum to a small section almost entirely concealed under the scutellum of the mesothorax. The pretergite (prt), if present, is indistinguishably fused with the posterior phragma of the mesothorax. A narrow prescutum (psc) is often visible, but it is closely united with the mesothoracic postscutellum ($psl_2$) often adhering to it when the mesothorax and metathorax are pulled apart. Prescutum (psc), scutum (sc) and scutellum (sl) are sometimes, as in the Corixidæ (Figure 19), Notonectidæ (Figure 16), Nabidæ (Figure 24), Cimicidæ and Berytidæ (Figure 22), inseparably fused together. In some cases, on the other hand, one, two, or all three of these sclerites are definitely marked off by sutures. The postscutellum (psl) is found in all gradations, from a brief, partially hidden plate, as in *Belostoma* (Figure 20), to a large, extensive sclerite, as in the Berytidæ (Figure 22).

In the Gerridæ (Figure 21) the homologies of the parts of the metanotum are not easily determined. There is apparently a short plate composing the scutoscutellum ($ssl_3$), rather long mesally and coming forward to a point on either side to reach the narrow wing bases, which are set somewhat forward. Behind this is the rather extensive postscutellum ($psl_3$), likewise extending forward in a point on each side, and very broadly joined to the epimeron ($em_3$).

In the Coreidæ (Figure 23) and similar forms a narrow, raised portion ($ce_3$), the cenchrus of Hemipterologists, extends along the upper margin of the epimeron ($em_3$) where the postalare ($poa_3$) joins it. This is possibly homologous with the parapleuron of Coleopterologists.

Pleuron. The pleuron of the metathorax is in general similar to that of the preceding segment. The distorted condition mentioned above is most noticeable in the Corixidæ (Figure 19), Notonectidæ (Figure 16) and Belostomatidæ (Figure 20). In *Corixa* (Figure 19) the coxa ($cx_3$) is very large and its base is covered by flaps of both episternum ($es_3$) and epimeron ($em_3$). The pleural suture ($p_3$) is nearly horizontal and lies very near the upper margin of the pleuron. The epimeron ($em_3$) is thus very narrow. Only in *Belostoma* (Figure 20) is the metathoracic episternum divided into anepisternum (aes) and katepisternum (kes). In *Notonecta* (Figure 16) and in *Belostoma* (Figure 20) the epimeron (em) does not overlap the coxa, but the episternum

(es) projects backward over it for some distance. With few exceptions, notably in the Nabidæ (Figure 24) and Cimicidæ, and possibly in some others, the coxæ (cx) of all Heteroptera are partially overlapped by the metapleural plates, the coxal attachment (x) being concealed and its position not usually recognizable externally. In *Gerris* (Figure 21), an elongate, cylindrical form, the base of the coxa is set in a bulging socket, as in the mesothorax, except that there is no cleft in this socket. In *Emesa* (Figure 14), another elongate form, the base of the hind coxa ($cx_3$) is partly covered by a pointed flap, while another pointed flap lies behind it.

The pleural suture ($p_3$), except in *Corixa* (Figure 19), *Notonecta* (Figure 16) and *Belostoma* (Figure 20) is absent in the metathorax of all forms studied. A coxal cleft ($c_3$) is often present, as in the Nepidæ, Berytidæ (Figure 22), Coreidæ (Figure 23) and many other forms, but it is not to be homologized with the coxal cleft ($c_2$) of the mesothorax, since it does not terminate at the coxal process (x), but is usually located in front of and below the coxa. Hence it is incorrect to use the metathoracic coxal cleft ($c_3$), as some writers, (Tower, 1914, for example) have done, as a "landmark" for separating episternum ($es_3$) and epimeron ($em_3$). The episternum ($es_3$) and epimeron ($em_3$) are always to be separated by the pleural suture ($p_3$), and when this is absent, as it is in these forms, we must take as a basis for the division of the pleuron, the two points which are the constant limits of this suture when it is present. Thus the episternum and epimeron can be exteriorly separated only by an imaginary line, representing the pleural suture, extending from the wing fulcrum to the articulation of the coxa (x). This conclusion is strengthened by the fact that on examination of the interior surface of the pleuron in certain forms where no pleural suture exists, one will find a more or less distinct ridge, extending in an irregular, but fairly definite line between the wing fulcrum and the coxal process. Now in all forms possessing a pleural suture there is to be found on the inner surface of the pleuron a corresponding pleural ridge, this ridge being the internal manifestation of the external pleural suture. Hence it is not incorrect to use this ridge, which is as constant as the suture, as a "landmark" in naming the pleural plates. The ridge has been represented by a dotted line in the figure of the squash bug (Figure 23). It would probably be

found in other forms where the pleural suture is absent, extending in a similar direction.

The general shape of the metapleuron in those forms where the pleural suture is absent is rectangular. In many forms the upper forward margin of the metathoracic pleuron extends slightly beneath, or at least anterior to the rear margin of the mesothoracic pleuron. This is true of the Nabidæ (Figure 24), Gerridæ (Figure 21) and Berytidæ (Figure 22) and of other forms not figured. It is particularly well shown in *Gerris* (Figure 21), where the rear wing lies very far forward, and the pleuron extends beyond it to support it.

In one of the elongate forms, *Emesa* (Figure 14), the epimera ($em_3$) of each side present the appearance of meeting dorsally and bridging the region behind the postscutellum ($psl_3$). Though this may seem an improbable conception, it may not be an impossible one, since it will be recalled that in the mesothorax of Odonata the two episterna meet in front of the notum in much the same fashion.

Openings of scent glands (sg) occur in a number of families. These are represented in the figure of the squash bug (Figure 23). The opening is located at the end of the coxal cleft ($c_3$) in the lower anterior corner of the episternum ($es_3$).

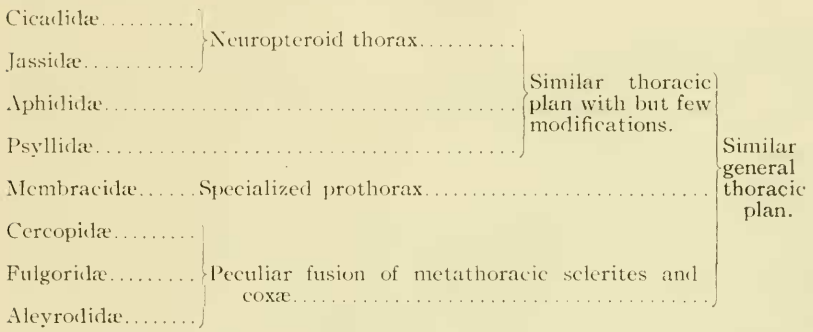
Sternum. The metasternum is quite like the mesosternum in the Heteroptera. It consists of one plate ($st_3$) usually and is not often separated from the episternum. A narrow postcoxale ($poc_3$), usually concealed, passes behind the coxa ($cx_3$) from epimeron ($em_3$) to sternum ($st_3$). This postcoxale is externally visible in *Coriscus* (Figure 24, $poc_3$).

## RELATIONSHIPS OF THE HEMIPTERA INDICATED BY THE THORACIC SCLERITES.

On account of the diversity in the thoracic structure of Hemiptera, it is difficult to interpret the relationships of the families. Moreover, there are in the sclerites of some forms modifications, the origin of which is uncertain, there being apparently no intermediate or ancestral conditions leading up to these modifications in the forms studied. Hence it has been possible only to group together certain families whose thoracic sclerites most resemble each other.

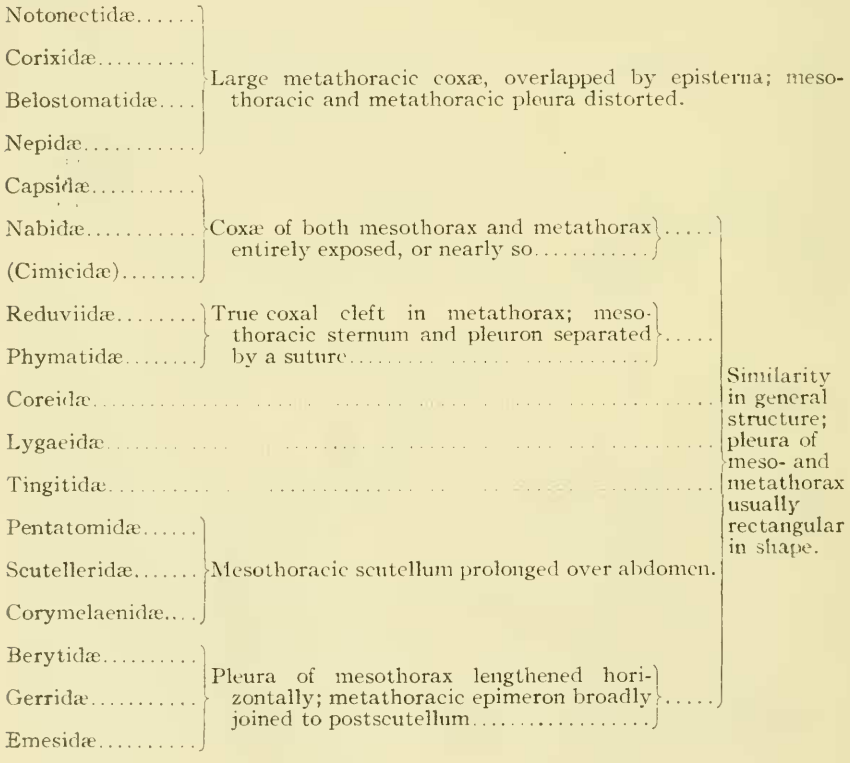
Among the Homoptera the Cicadidæ exhibit certain features in common with the Jassidæ, of which the most striking is the

Neuropteroid mesothoracic episternum. The general plan of the Cicadid thorax is followed in the Aphididæ, Membracidæ, Psyllidæ, Cercopidæ and Fulgoridæ. Of these, however, all but the Aphididæ and perhaps the Psyllidæ present striking modifications, such as the extreme specialization of the Membracid prothorax, and the remarkable fusion of the coxæ and the metathoracic pleura of the Fulgoridæ, the latter of which seems to have originated in a similar condition (less marked) in the Cercopidæ. The Membracidæ and Fulgoridæ, therefore, seem to be nearly related with respect to the thorax. The thorax of the Aleyrodidæ, being extremely small and lacking in pigment, cannot be carefully compared with that of the other families. Its large metathoracic coxa, immovably fused with the pleuron, may connect it with the Fulgoridæ. The following diagram illustrates to some extent the relationships shown by the thorax, without regard to primitiveness.




In the Heteroptera the thoracic structures of all the families are similar in their general composition. The relation of the coxæ to the pleural plates differs to some extent and may in a way serve to indicate some of the more general relationships. The Notonectidæ, Corixidæ, Belostomatidæ and Nepidæ are apparently related, both because of the distorted condition of the thorax, mentioned above, and from the large size of the metacoxa, which is overlapped more or less by the pleural plates. The remaining families studied in this paper seem very similar in the construction of the thorax. In the Capsidæ, Nabidæ and Cimicidæ the mesothoracic and metathoracic coxæ are entirely exposed, or nearly so, not being overlapped by the pleural plates. The relation of the Cimicidæ to the other two is

somewhat problematic, the flattening of the thorax and consequent contraction of the thoracic plates giving these insects a unique place in the order. The Reduviidæ and Phymatidæ, unlike any others of the families studied, have a true coxal cleft in the metathorax, homologous with that in the mesothorax. The Pentatomidæ, Scutelleridæ and Corymelænidæ may be grouped on account of the extremely developed mesothoracic scutellum, which projects far over the abdomen. The chief reasons for uniting the Berytidæ and Gerridæ in the diagram below are the horizontal lengthening of the mesopleura, and the metathoracic scutellum, which in both joins broadly with the epimeron ventrad. The Emesidæ also resemble these two families, though their relation to them may be questioned. The following diagram is an attempt at grouping those Heteropterous families, which appear from their thoracic sclerites to be related.



It will be seen that these results are not entirely in harmony with the conclusions of certain writers (Osborn, 1896; Kirkaldy, 1908, 1909; Handlirsch, 1906–'08; Reuter, 1910), concerning the phylogeny of the Hemiptera. This, of course, is to be expected, since the grouping above is based entirely on the morphology of the thorax. Handlirsch, 1906–'08, places the Aleyrodidæ near the Fulgoridæ, and though superficially the two families do not seem related, the thoracic sclerites support this grouping. The arrangement of other Homopterous families followed by writers on phylogeny is not generally borne out by the morphology of the thorax.

The Notonectidæ, Corixidæ, Belostomatidæ and Nepidæ are placed together by Osborn, 1896, Handlirsch, 1906–'08, and Reuter, 1910, but Kirkaldy, 1908, 1909, separates the Nepidæ from the others. Both Handlirsch, 1906–'08, and Reuter, 1910, place the Capsidæ, Cimicidæ and Nabidæ fairly near each other, and this arrangement agrees with their thoracic structure. The close connection of the Reduviidæ and Phymatidæ is shown by Kirkaldy, 1908, 1909, Handlirsch, 1906–'08, and Reuter, 1910. The Pentatomidæ, Scutelleridæ and Corymelænidæ are usually placed together by writers on phylogeny.

It will thus be seen that relationships shown by the thoracic sclerites are supported in part by the conclusions of writers on phylogeny, especially Handlirsch and Reuter. In the relationships of the Homopterous families, of the Coreidæ, Lygæidæ and Tingitidæ, and of the Berytidæ, Gerridæ and Emesidæ the results obtained in this study do not agree with those of the writers mentioned. More extensive and thorough study of other morphological features as well as of the thorax will be necessary to show the true relationships of these groups.

WORKS REFERRED TO IN THIS PAPER.

1820. **Audouin.** L'anatomie comparative des parties solides des insectes. Ann. gen. des Sci. Phys., Tome 7, pp. 396-406. Rapport par Cuvier.

1908. **Crampton.** Beitrag zur Homologie der Thorakalsklerite der Insekten. Diss. Berlin.

1909. ———. Contribution to the comparative morphology of the thoracic sclerites of insects. Proc. Acad. Nat. Sci. Phila., pp. 3-54.

1914A. ———. Notes on the thoracic sclerites of winged insects. Ent. News, Vol. 25, pp. 15-25.

1914B. ———. The ground plan of a typical thoracic segment in winged insects. Zool. Anz., Bd. XLIV, Nr. 2, pp. 56-67.

1914C. ———. On the misuse of the terms parapteron, hypopteron, tegula, squamula, patagium and scapula. Jl. N. Y. Ent. Soc., Vol. XXII, pp. 248, 261.

1915. **Crampton & Hasey.** The Basel Sclerites of the Leg in Insects. Zool. Jahrb. Abt. Anat., Bd. 39, pp. 1-26.

1914. **Crawford.** A monograph of the jumping plant-lice, or Psyllidæ of the New World. U. S. Nat. Mus. Bul. 85.

1875. **Fieber.** Les Cicadines d'Europe. Trans. from German by Reiber. Strasburg.

1906-08. **Handlirsch.** Die fossilen Insekten und die Phylogenie der rezenten Formen. Leipzig.

1890. **Hansen.** Gamle og nye Hovedmomenter til Cicadariernes Morphologi og Systematik. Ent. Tidskrift, Vol. XI, pp. 19-76. (Trans. into English in part, but plates not given, in the Entomologist, Vols. 33, 34, 35, 36).

1899. **Heymons.** Beitrage zur Morphologie und Entwicklungsgeschichte der Rhynchoten. Nova Acta Abh. der Kaiserl. Leop.-Carol., Deutsch. Akad. der Naturf. Bd. LXXIV, pp. 353-455.

1908. **Kirkaldy.** Some remarks on the phylogeny of the Hemiptera-Heteroptera. Can. Ent. Vol. 40, p. 357.

1909. ———. Catalogue of the Hemiptera (Heteroptera). Vol. 1. Berlin.

1896. **Osborn.** The phylogeny of Hemiptera. Proc. Ent. Soc. Washington, Vol. III, p. 185.

1884. **Osten-Sacken.** An essay on comparative chaetotaxy. Trans. Ent. Soc. London, 1884, Part 4, pp. 497-517.

1910. **Reuter.** Neue Beitrage zur Phylogenie und Systematik der Miriden nebst einleitenden Bemerkungen uber die Phylogenie der Heteropteren-Familien. Helsingfors. Acta Soc. Sc. Fennicæ. Bd. 37, Nr. 3.

1907. **Smith and Grossbeck.** Studies in certain Cicada species. Ent. News. Vol. XVIII, pp. 116-129.

1909. **Snodgrass.** The thorax of insects and the articulation of the wings. Proc. U. S. Nat. Mus. Vol. 36, pp. 511-595.

1910. ———. The anatomy of the honey bee. U. S. D. A., Bur. of Ent., Technical Series. No. 18.

1910. ———. The thorax of the Hymenoptera. Proc. U. S. Nat. Mus., Vol. 39, pp. 37-91.

1913. **Tower.** The external anatomy of the squash bug, Anasa tristis DeG. Ann. Ent. Soc. Am., Vol. VI, pp. 427-441.

## EXPLANATION OF PLATES.

(NOTE: All are lateral views unless otherwise indicated).

### PLATE XX.

Fig. 1. *Cicada tibicen* Cicadidæ). Mesonotum and wing articulation. Dorsal view.
Fig. 2. Same. Pro-, meso- and metathorax. Ventral view.
Fig. 3. Same. Prothorax.
Fig. 4. Same. Mesothorax. (A combination of conditions in *C. tibicen* and in *Cryptotympana epithesia*).
Fig. 5. Same. Metathorax.
Fig. 6. *Aphrophora* sp. (Cercopidæ). Metathoracic pleuron and sternum.

### PLATE XXI.

Fig. 7. *Draeculacephala* sp. (Jassidæ). Mesothorax.
Fig. 8. *Ormenis* sp. (Fulgoridæ). Metathoracic pleuron and sternum.
Fig. 9. *Fulgora* sp. (Fulgoridæ). Metathorax.
Fig. 10. *Apsylla cistella* (Psyllidæ). Pro-, meso- and metathorax. From CRAWFORD, 1914.
Fig. 11. *Arytaina robusta* (Psyllidæ). Pro-, meso- and metathorax. From CRAWFORD, 1914.
Fig. 12. *Pemphigus acerifolia* (Aphididæ). Meso- and metathorax. See footnote page 234.
Fig. 13. *Aleyrodes vaporariorum*. (Aleyrodidæ). Metathoracic pleuron and coxa.

### PLATE XXII.

Fig. 14. *Emesa* sp. (Emesidæ). Meso- and metathorax.
Fig. 15. *Notonecta* sp. (Notonectidæ). Mesothorax.
Fig. 16. Same. Metathorax.
Fig. 17. *Ranatra* sp. (Nepidæ). Mesothorax.
Fig. 18. *Belostoma americana* (Belostomatidæ). Mesothorax.
Fig. 19. *Corixa* sp. (Corixidæ). Meso- and metathorax.
Fig. 20. *Belostoma americana* (Belostomatidæ). Metathorax.
Fig. 21. *Gerris* sp. (Gerridæ). Meso- and metathorax.

### PLATE XXIII.

Fig. 22. *Neides* sp. (Berytidæ). Meso- and metathorax.
Fig. 23. *Anasa tristis* (Coreidæ). Meso- and metathorax.
Fig. 24. *Coriscus* sp. (Nabidæ). Meso- and metathorax.
Fig. 25. *Thyreocoris* sp. (Thyreocoridæ). Meso- and metathorax.

## ABBREVIATIONS USED IN THE PLATES.

a, suture dividing episternum.
aba, anterior basalare.
aem, anepimeron.
aes, anepisternum.
aph, anterior phragma.
apt, adanal pterale.
asa, anterior subalare.
b, suture dividing epimeron.
bs, basisternite.
c, coxal cleft.
ce, cenchrus.
cx, coxa.
em, epimeron.
es, episternum.
fs, furcasternite.
hyp, hypopteron.
is, intersegmentalia.
it, intertergite
kem, katepimeron.
kes, katepisternum.
mc, meracanthus.
me, meron.
mes, median portion of episternum.
n, notum.
npt, notopterale.
op, operculum.
p, pleural suture.
pba, posterior basalare.
pcx, precoxale.
poa, postalare.
poc, postcoxale.
pra, prealare.
prt, pretergite.
psa, posterior subalare.
psc, prescutum.
psl, postscutellum.
pt, peritreme, surrounding spiracle.
sa, subalare.
sc, scutum.
sg, opening of scent glands.
sl, scutellum.
sp, spiracle.
sr, supraalare or suralare.
ssl, scuto-scutellum (prt—psc—sc—sl).
tg, tegula.
tn, trochantin.
tr, trochanter.
vcx, veracoxa.
x, coxal articulation. (Location so indicated when concealed).

The subscripts 1, 2 and 3 indicate respectively the pro-, meso- and metathorax.